On the Significance of the Bivalve *Acila gettysburgensis* (Reagan) in Middle Tertiary Chronostratigraphy of the Pacific Coast

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(3 Text figures)

The chronozone of *Acila gettysburgensis* (Reagan) was first designated by Schenck (1936: 44) as an Oligocene and Miocene "biozone" for the Pacific Coast States. It is the youngest in a set of 3 sequential *Acila* chronozones defined by Schenck extending from the late Eocene through the early Miocene. Taxonomic and biostratigraphic work during the past 40 years have changed, somewhat, the concept of *A. gettysburgensis* and, more importantly, have clarified its stratigraphic range so that it is now possible to utilize it more effectively in middle Tertiary chronostratigraphy.

Acila gettysburgensis (Figure 1) is referable to the subgenus *Acila* s. s. This distinctive subgenus, distinguished by its well-developed rostral sinus, seems to have originated

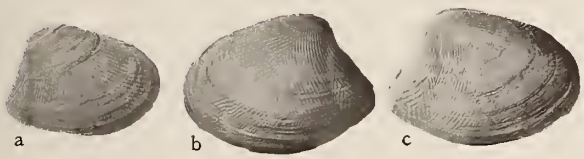

Figure 1

Acila gettysburgensis (Reagan)

a) holotype, USNM 328302, upper member of the Twin River Formation, Gettysburg, Washington; b and c) USNM 240208, USGS loc. M2509, Unit I of the Astoria Formation, Grays River quadrangle, Washington [all figures natural size]

during the late Oligocene in the eastern North Pacific Ocean. Its initial occurrences in Central America, South America, and the western North Pacific (Schenck, 1936) appear to be of somewhat younger age. The subgenus is particularly useful in stratigraphic correlation in the eastern North Pacific owing to its restricted occurrences in the stratigraphic record: during the provincial late Oligocene and early Miocene (*A. gettysburgensis*) and, again, during the Pliocene (*A. semirostrata*).

Acila gettysburgensis has been treated systematically by Schenck (1936), Moore (1963), and Kanno (1971). In the eastern North Pacific it ranged from California to the Gulf of Alaska (Figure 2) during the middle Tertiary. The species has also been reported from Sakhalin (Kristofovich, 1964) in the western North Pacific. Schenck (*op. cit.*), in calling attention to the potential utility of *A. gettysburgensis* in chronostratigraphy, noted that it ranged throughout the upper part of the Oligocene [the late Oligocene and early Miocene of this report], a period of time keyed to the then poorly known Zemorrian and Saucesian Stages (Kleinpell, 1934) of the benthic foraminiferal chronology. Although he considered the peak abundance to have occurred during the Zemorrian Age, a fact that has been borne out by subsequent work (Durham, 1944; Moore, 1963; Wolfe & McKee, 1972), he noted that its chron was in part younger based upon occurrences in the Astoria formation of Oregon and, presumably, in the "'Monterey' formation" of the Santa Cruz Mountains near Point Ano Nuevo, central California. The "Monterey" occurrence, if correct, would extend the range of *A. gettysburgensis* into the provincial Pliocene inasmuch as it is actually from the Santa Cruz Mudstone of Clark (1966). The *Acila* in question is actually the late Neogene species *A. semirostrata* (Grant & Gale, 1931) based upon restudy of Schenck's (1936: 80; plt. 13, figs. 4, 9) specimen and an additional specimen collected from the same exposure (USGS loc. M5150). All of the other occurrences of *A. gettysburgensis* are near the provincial Oligocene/Miocene boundary.

The lowest stratigraphic occurrences of *Acila gettysburgensis* mark the base of the Matlockian Stage (Armentrout, 1975) or "Blakeley" stage (Weaver *et al.*, 1944) of the provincial megainvertebrate chronology. They fol-

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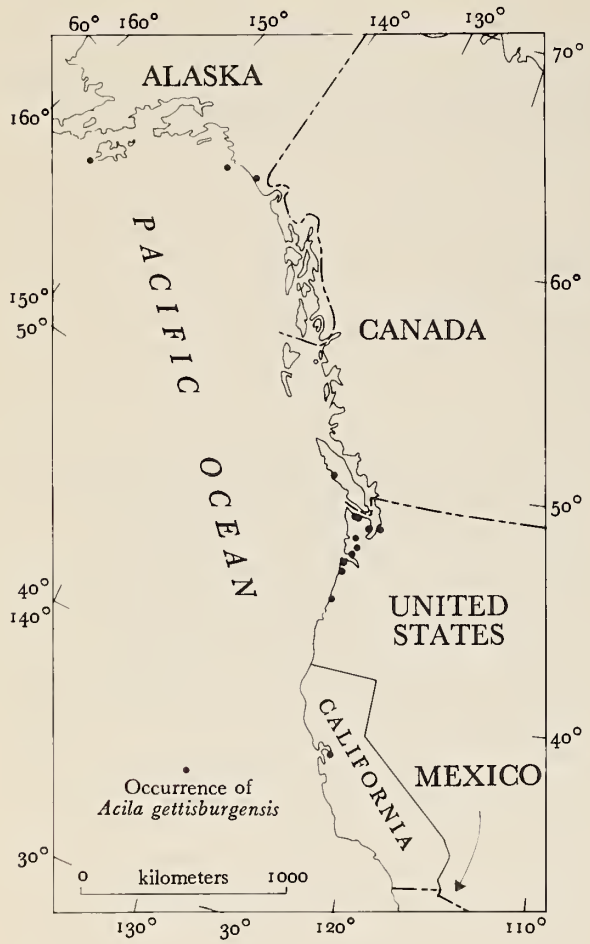

Figure 2

Index map of the eastern North Pacific Ocean showing some occurrences of *Acila gettysburgensis* (Reagan)

low, in stratigraphic succession, the chronozone of the Galvinian Stage (Armentrout, 1975 [= Refugian Stage of Schenck & Kleinpell (1936)] index species *A. shumardi* (Dall, 1909). The seemingly complementary relationship between these 2 chronozones is, however, fortuitous because the species belong to different subgenera. The relationship of these chronozones to Pacific coast invertebrate megafaunal stages is shown in Figure 3.

The highest stratigraphic occurrences of *Acila gettysburgensis* are more difficult to determine. There are a few

SERIES	*ACILA* Chronozone	STAGE		
		Pacific NW Megafaunal	California Megafaunal	California Microfaunal
Lower Miocene	*Acila gettisburgensis*	Pillarian	"Vaqueros"	Saucesian (lower part)
		Juanian		Zemorrian
		Matlockian [= "Blakeley"]	Unnamed (Addicott, 1973)	
Oligocene	*A. shumardi*	Galvinian (upper part) ["Lincoln"]	Refugian (upper part)	Refugian (upper part)

Figure 3

Correlation of middle Tertiary *Acila* chronozones with Pacific coast molluscan and benthic foraminiferal stages. The Refugian Stage (Schenck & Kleinpell, 1936) was defined on both molluscan and foraminiferal data

records (Howe, 1926; Moore, 1963; Wolfe & McKee, 1972; and Armentrout, 1973) from strata that have been assigned to the provincial middle Miocene. These would be placed in the recently named Newportian Stage (Addicott, 1976c); they have been correlated (Howe, 1926; Addicott, 1967) with the "Temblor" Stage (see Addicott, 1972) of California. Reexamination of each of these records, as will be subsequently shown, now leads me to the conclusion that there are no bona fide middle Miocene (Newportian) occurrences of *A. gettysburgensis* and that the chron of this species is restricted to the provincial late Oligocene and early Miocene of the Pacific coast (Figure 3). The highest stratigraphic occurrences of this species are in strata referable to the lower Miocene Pillarian Stage (Addicott, 1976c).

In northwestern Washington *Acila gettysburgensis* occurs in the upper member of the Twin River Formation (Durham, 1944; Addicott, 1976a). The type locality of the species is in this unit and is referable to the lower part of the Matlockian or "Blakeley" Stage (Addicott, 1967b). On the south flank of the Olympic Mountains near Aberdeen, Washington, *A. gettysburgensis* occurs in the lowermost part of the Astoria? Formation on Canyon River (USGS loc. M1540 and M3074). The co-occurrence of *Vertipecten* (Armentrout, 1973) with these specimens suggests that the record is of early Miocene provincial age, referable to the Pillarian stage, and coeval with the faunas of the Clallam Formation and the Nye Mudstone of

northwestern Oregon. Foraminifers from these strata have been determined by RAU (1966: 41 - 42) to be of early Saucesian age which further supports correlation with pre-middle Miocene, Pillarian molluscan faunas of Oregon and Washington.

Farther south, *Acila gettysburgensis* has been recorded from the lowest part (Unit I) of WOLFE & MCKEE's (1972) Astoria Formation of the Grays River quadrangle. Unit I is here correlated with HOWE's (1976) middle shale member of the Astoria Formation at Astoria, Oregon. some 25 km to the southwest, and also with the Nye Mudstone of the Newport embayment. Foraminiferal data from these two parts of the Columbia River embayment (RAU in WOLFE & MCKEE, 1962; DODDS, 1970) are entirely compatible with this correlation. Both of these stratigraphic units are referable to the provincial early Miocene Pillarian Stage. Occurrences in Unit I of the Astoria Formation in the Grays River quadrangle are stratigraphically below mollusk assemblages that are here correlated with the middle Miocene Newportian Stage, typified by the fauna of the Astoria Formation of the Newport Embayment, northwestern Oregon.

Occurrences of *Acila gettysburgensis* in the type area of the Astoria Formation at Astoria. Oregon. are correlated with the Pillarian Stage (ADDICOTT, 1976c) of late early Miocene age. Benthic foraminiferal studies by DODDS (1970) indicate that the stratigraphically highest part of the Astoria near the type area – HOWE's (1926) Middle Siltstone Member – is referable to the *Siphogenerina transversa* Zone. Accordingly, this 210 meter-thick unit is of early Saucesian Age and is, therefore, coeval with the Nye Mudstone of the Newport Embayment. Thus provincial age and correlation indicated by benthic foraminifers parallels the apparent age suggested by the molluscan data.

The Astoria Formation of the Newport Embayment and its molluscan fauna serve as a generalized reference stratotype for the Newportian Stage (ADDICOTT, 1976c) and for middle Miocene correlation in the Pacific Northwest States. *Acila* is of common occurrence in exposures of the Astoria in this embayment but of the 40-odd localities from which the genus is recorded (MOORE, 1963) only one has yielded specimens of *A. gettysburgensis*. All of the other records are of *Acila (Truncacila) conradi* (Meek), a smaller, non-rostrate species readily distinguished from *A. gettysburgensis*. *Acila gettysburgensis* was initially recorded from the Nye Mudstone by SCHENCK (1927).

The one record of *Acila gettysburgensis* from this embayment (MOORE, 1963: 54; plt. 12, fig. 10) deserves further consideration. It is from a generalized locality about 30 - 40 m above the base of the Astoria Formation on the south side of Yaquina Head (MOORE, *op. cit.*, table 2, loc. 156). The small area from which this species was collected has yielded 2 other mollusks – *Aturia angustata* (Conrad) and *Aforia tricarinata* Addicott – that are not known to occur in undoubted middle Miocene exposures of the Astoria Formation. *Aturia angustata* has a well-defined pre-middle Miocene record along the east Pacific margin (ADDICOTT, 1976b) and *Aforia tricarinata* has a few other records from the Newport embayment (JAVIDPOUR, 1973), all of which are stratigraphically below the Astoria Formation. Two doubtful occurrences from exposures of the Astoria Formation west of Newport are also listed by MOORE (*op. cit.*, table 2, locs. 174 and 177) but both are from localities in the upper part of the underlying Nye Mudstone according to SNAVELY and others (1964, 1976). The lack of additional records of *A. gettysburgensis* from undoubted localities in the Astoria Formation of the Newport embayment, coupled with 1) the abundance of the genus *Acila* in these strata, 2) the other mollusks occurring with *A. gettysburgensis* that seem to be out of place stratigraphically, and 3) the stratigraphic position low in the Astoria Formation, all suggest that the sandy beds in this area south of Yaquina Head may be equivalent to exposures of the highest part of the Nye Mudstone south of the mouth of Yaquina Bay. In the light of this evidence, this occurrence of *A. gettysburgensis* is here considered to be of provincial early Miocene age and referable to the Pillarian Stage.

Acila gettysburgensis is restricted to strata of pre-middle Miocene age in the Gulf of Alaska. It occurs in the Oligocene to lower Miocene Poul Creek Formation in onshore parts of the Gulf (KANNO, 1971) and in lower Miocene strata on Sitkinak Island (R. C. Allison, written communication, January, 1976). It is also reported from the Yakataga Formation of Kayak Island (ADDICOTT *in* PLAFKER, 1974). Mollusks of the Yakataga Formation of Kayak Island are of early Miocene age indicating that this insular occurrence of the formation is relatively older than any of the onshore exposures, all of which are of middle Miocene or younger age (PLAFKER & ADDICOTT, 1976).

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